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INSTRUMENT FOR MEASUREMENT OF THE DROPTIME/BALANCE TIME OF DME

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ABSTRACT

Droptime measurement is one of the useful techniques to evaluate the interfacial tension data in adsorption studies at the mercury/solution interfaces. A simple electronic circuit to display the droptime digitally is described. The operation of the unit is tested with 545 CRO delaytime triggering and is found to work consistently in the conventional ac bridge set up.

Key Words: Dropping mercury electrode, droptime, balance time

INTRODUCTION

Automatic droptime measuring unit is of great use for fundamental studies of the state of the electrical double layer. It can give valuable thermodynamic information on the adsorption of ions and molecules at mercury electrodes. Various approaches (1-3) have been made to determine the droptime precisely especially in solution where the concentration of active substances is very low. Some of them are:

(i) The mechanical-electric method: The falling mercury drop acts mechanically upon the membrane of a microphone or a transducer from which the output pulse is amplified and used for triggering.

(ii) The photo-electric method: The falling mercury drop blanks off a constant light beam and the resulting photoelectric effect is used for triggering.

(iii) The impedance method: The periodic change of the electric impedance with the change of the surface area of mercury drop is sensed and droptime is determined.

Each method has its own advantages and disadvantages. In this laboratory ac bridge set up for differential capacitance measurement is being used. Using CRO with Delaytime sweep facility, balance time is determined. To automate this laborious measurement, a digital balance time indicator is designed and tested for use. The periodic unbalanced signal from the ac bridge in synchronism with the fall of mercury drop is used for the measurement of droptime. Bridge circuit to determine the capacitance of grown mercury drop. Knowing the capacitance and balance time, capacitance per unit area is estimated at various polarising potentials to evaluate other parameters.

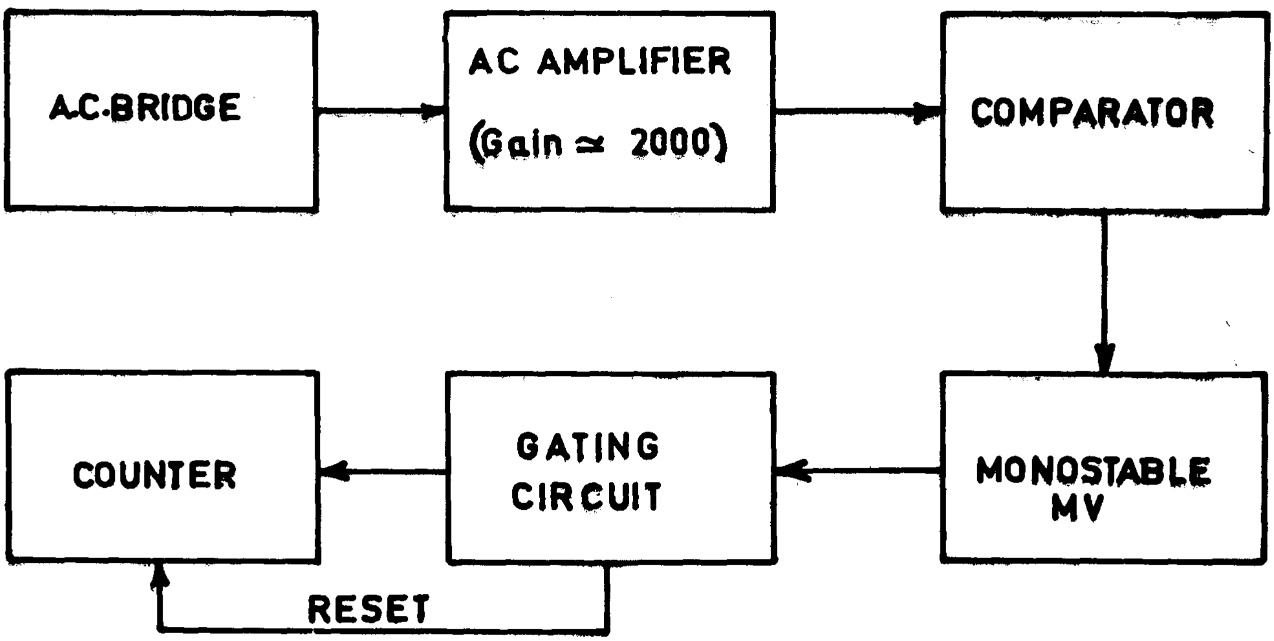

Fig.1. Block diagram of balance time indicator

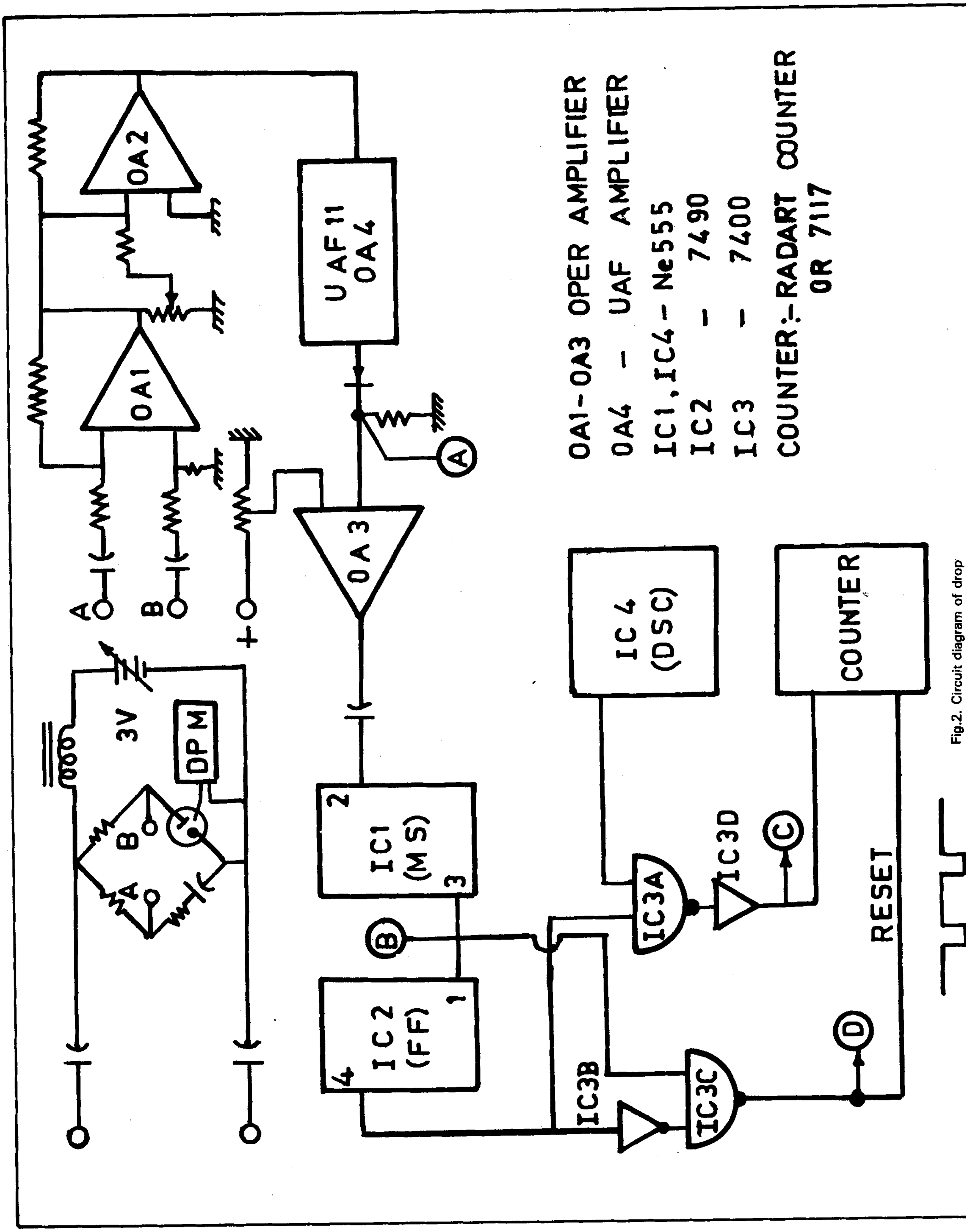

Fig.2. Circuit diagram of drop

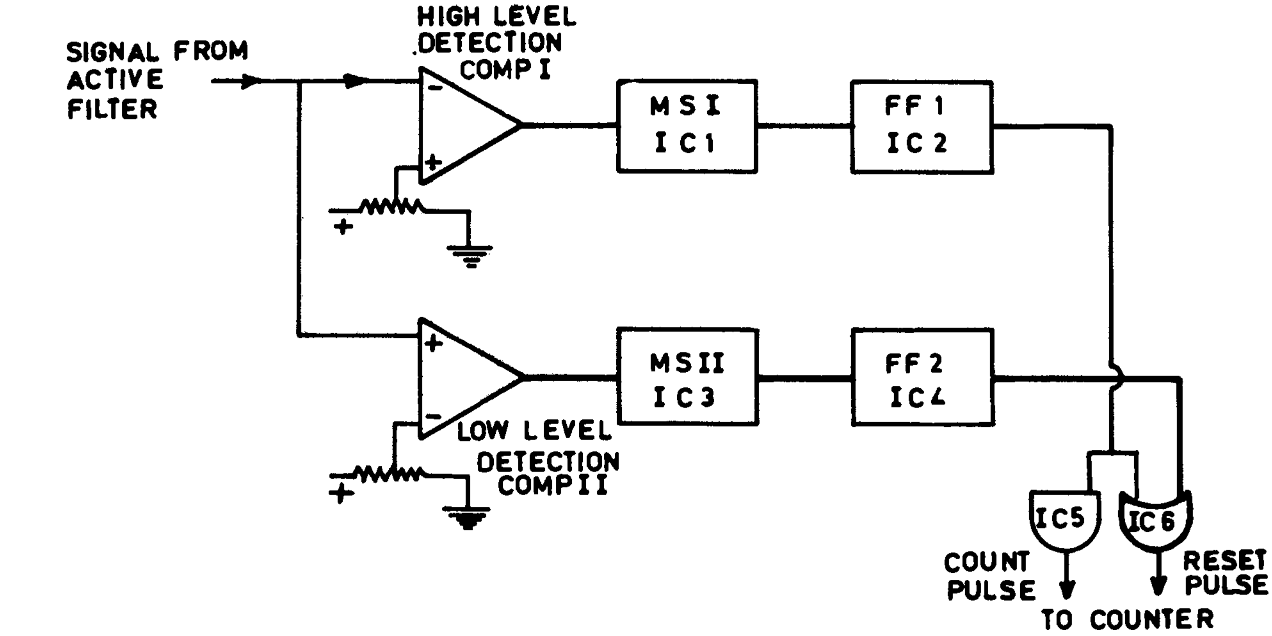

Fig.3. Circuit diagram of balance time indicator

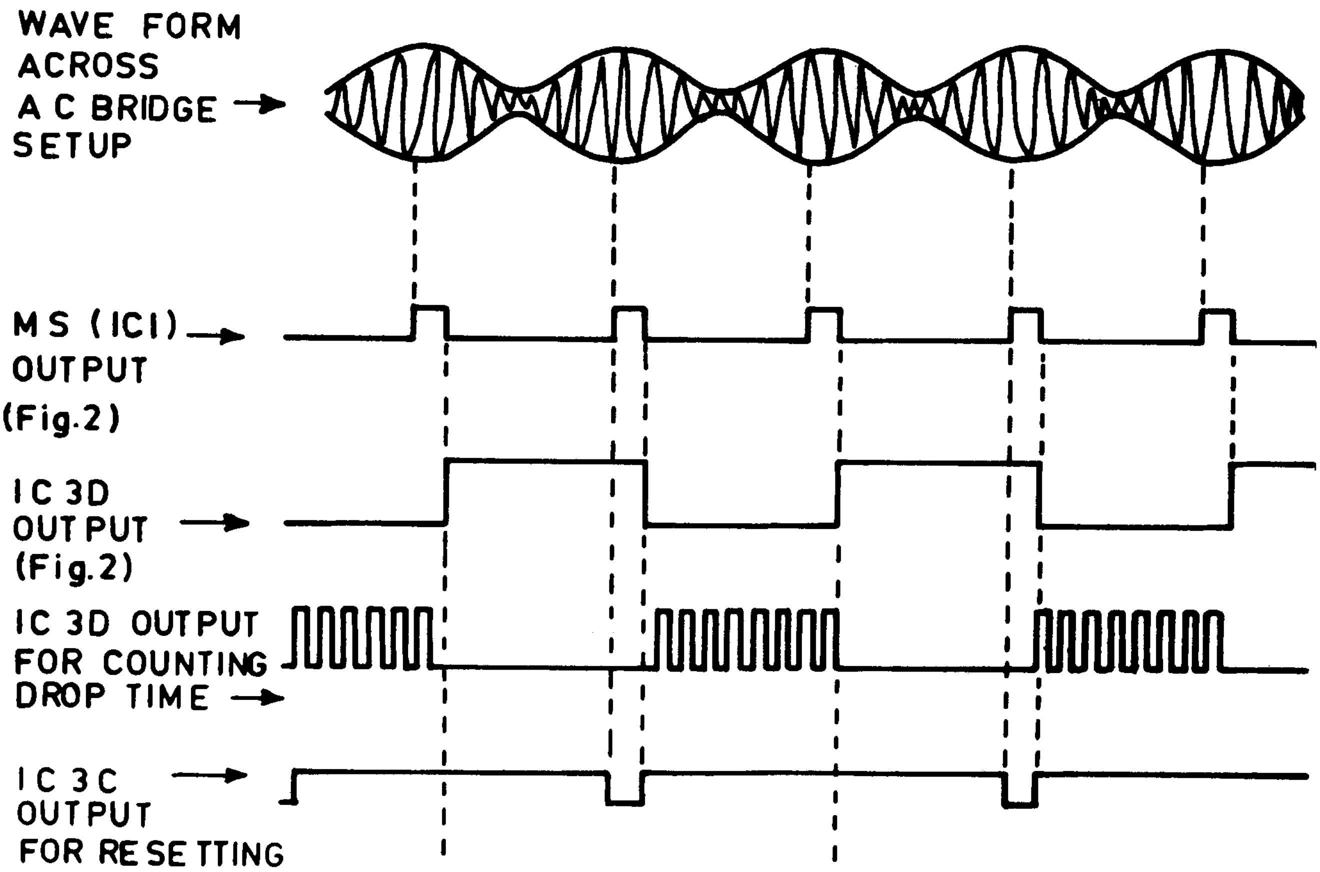

Fig.4. Waveforms while measuring drop time

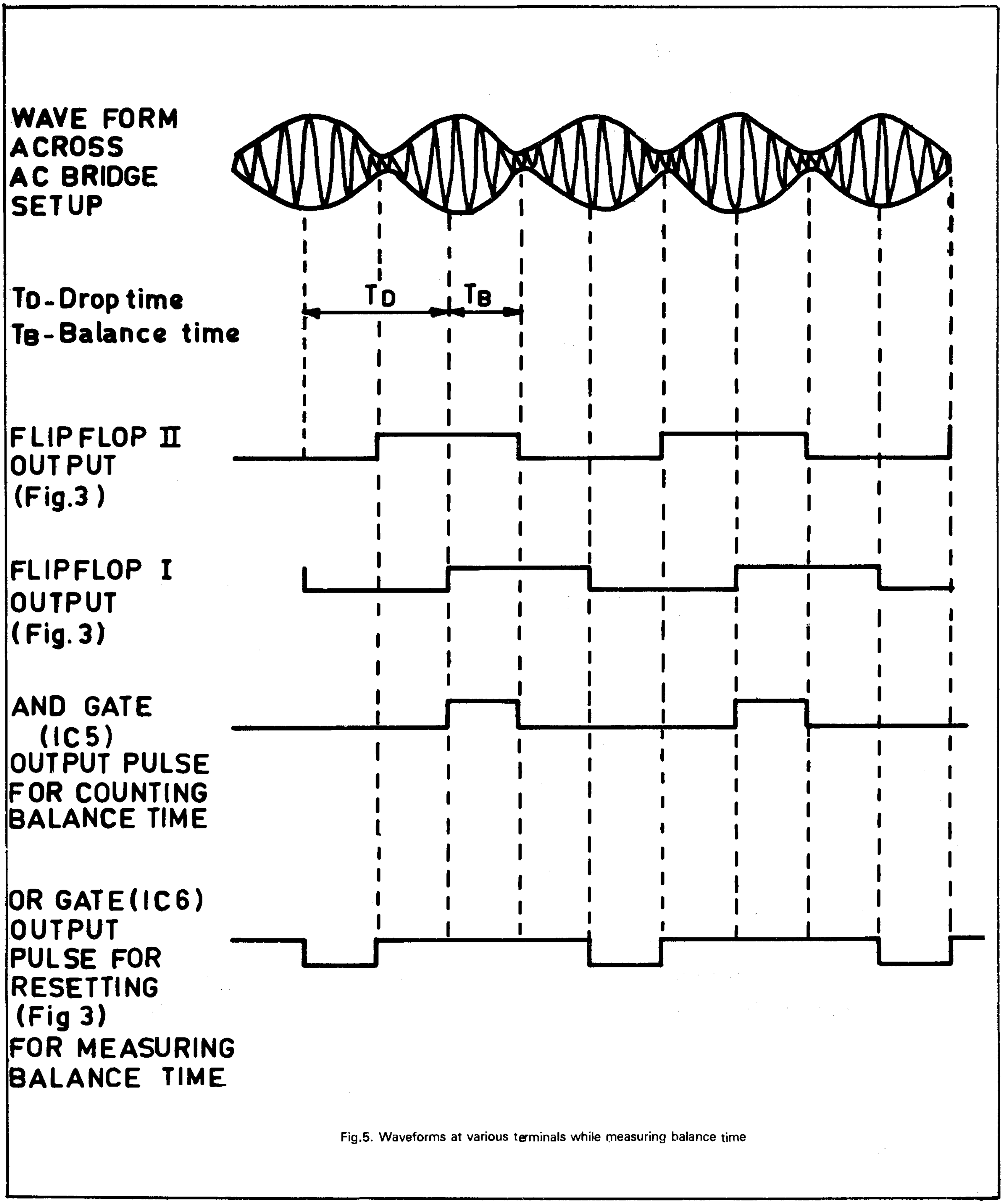

Fig.5. Waveforms at various terminals while measuring balance time

INSTRUMENT DESCRIPTION

The design details of a balance time indicator is briefly described. Signal from the ac bridge detector terminals is given as input. The instrument input stage eliminates AC pickup and provides enough amplification to determine precisely the droptime to a precision of 0.001 sec. The pulse output from the bridge at the instant of breakaway of the drop is gated and the interval between the consecutive drops is measured digitally. The automatic resetting facility allows the circuits to be returned to the ready state before the dropfall so that measurements are possible on alternate consecutive drops. This greatly improves the speed of measurement. This instrument can be used as droptime indicator as a stand alone unit or as a balance time indicator (an integrator to detect the minimum signal is incorporated) with ac bridge to determine the capacitance per unit area.

Mode of operation

The mode of operation can be best understood by using the block diagram as shown in figure 1. The circuit diagrams are shown in figures 2 and 3. AC bridge is tentatively balanced for minimum signal for the fully grown mercury drop. The unbalanced signal from the bridge is amplified by 1000 times using an ac differential amplifier. Active Filter UAF 11 is used to separate out the 1 KHz signal. The resultant waveforms are shown in figures 4 and 5. Using comparator block and monostable multivibrator pulses corresponding to each peak without superimposition of 1 KHz pulses are generated using Gating circuits. Pulse width in proportion to droptime is generated. This signal is mixed with the standard crystal oscillator signal using AND circuit for counting. Using a counter, the droptime is measured and displayed nearby for one drop interval. Just before the occurrence of new measuring interval, a reset pulse is given to the counter to start for new measurement. The automatic resetting facility allows the circuits to be returned to the ready state before the dropfalls so that the measurements are possible on alternate consecutive drops. This greatly improves the ease and speed of measurement.

Circuitry used (Vide figures 2 and 3):

Since the signal to be measured is in the order of a few millivolts, a low drift high precision differential amplifier is used for initial amplification. IC OA4 is the active filter used to reject pickup signal and its unbalanced output signal is used to find out the droptime.

Generation of the triggering pulse for pulse width is done by the comparator OA3 in which the comparing voltage is present to about 2 volts. On sensing this level pulses from unbalanced signal are generated which in turn triggers a monostable multivibrator IC 1. The monostable pulse width is set to take into account the transients. The falling edge of this pulse triggers the flipflop IC 2 and it generates pulse train whose width is in proportion to the droptime. IC 4 generates the clock signal for counting. This signal is mixed with the signal using AND circuit from flipflop IC 2 at IC 3A and output of that is given to counter chip IC 9 for counting the period. It is displayed nearly for the droptime interval. IC 3C generates the reset signal just before the beginning of counting cycle whereby the counter is reset to zero to set for new droptime measuring cycle. This way the droptime of dropping mercury electrode is measured in alternate cycles.

RESULTS

The unit was checked in the conventional AC bridge set up with 543 Tektronix Oscilloscope. Barometer height of mercury is varied to get the various droptimes. Using delaytime multiplier in CRO and by the developed unit, the droptime is recorded. The results are shown in Table I which give a good agreement between the two.

Table I: Comparison of droptime measurements

S.No	Mercury column (Barometer) height (cm)	CRO reading (in delay time sweep mode) (Sec)	Developed instrument's reading (Sec)
1.	41.5	8.92	8.943
2.	45.5	8.22	8.223
3.	48.0	7.73	7.736
4.	50.5	7.34	7.349
5.	52.8	7.00	7.002
6.	56.2	6.57	6.574
7.	59.6	6.19	6.183
8.	61.8	5.97	5.961
9.	65.4	5.62	5.625
10.	68.0	5.36	5.357

This instrument can be easily fabricated as it involves only ten IC chips whereby we can avoid the use of costly oscilloscope having long delaytime triggering facility. It is simple and reliable and saves time and labour. The specification of the instrument are:

Gain of the system : 1000 to 3000 (variable)
Frequency selection : Set to 1 KHz
Timer accuracy : Min. 0.01 sec (can be improved lower or higher) Max. 60 minutes

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REFERENCES

1. I G R Gutz, *J Electroanal Chem,* 179 (1984) 99

2. G J Hills and R Payne, *Trans Faraday Soc*,61 (1965) 316

3. P D Tyma, M J Weaver and C G Enke, *Anal Chem*,51 (1979) 2300

4. J P Pearce and F C Anson, *Anal Chem*,49 (1977) 1270

5. CH Yarnitzky, *J Electroanal Chem, 51* (1974) 207